Satellite thermal infrared analysis for urban surface temperature estimation at local scale

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ABSTRACT

How people live, work, move from place to place, what they consume and the technology they use all affect the fabric, morphology and emissions in a city, which in turn affect the urban climate. The Urban Energy Budget (UEB) accounts for the 3D nature of cities, quantifying the urban energy fluxes into, out of and the storage change within a control volume. Both Earth system science and urban planning communities need spatially disaggregated UEB data at local scale (order 100 m or better) to assess the climate of cities. Such information is practically impossible to derive by in-situ flux measurements for extensive areas. Thus, Earth Observation (EO) provides a great alternative for estimating spatio-temporal patterns of the UEB components, but remains a challenging task. The estimation of urban energy fluxes requires frequent and accurate monitoring of land surface temperature (LST), at the local scale. Since no space-borne sensor provides frequent thermal infrared (TIR) imagery at high spatial and temporal resolution, downscaling techniques are applied to TIR remote sensing data to enhance their spatial resolution. Synergistic methods that combine the spatial information from visible and near-infrared observations with the more frequent, but low-resolution surface temperature patterns derived by TIR imagery provide excellent means for obtaining frequent LST estimates at the local scale in cities. The accuracy of the downscaled LST is critical, especially when used for the estimation of energy fluxes. A downscaling technique is presented for improving the spatial resolution of TIR observations and the subsequent LST estimation. The method is applied for London, United Kingdom, Basel, Switzerland and Heraklion, Greece. A large number of EO data from different sensors are used to produce LST maps of 100 m spatial resolution, four times per day. The derived LST was validated using in-situ thermal radiation measurements from flux towers installed in Basel and London. The accuracy of the derived LST maps, was assessed by comparison with higher resolution LST products.